

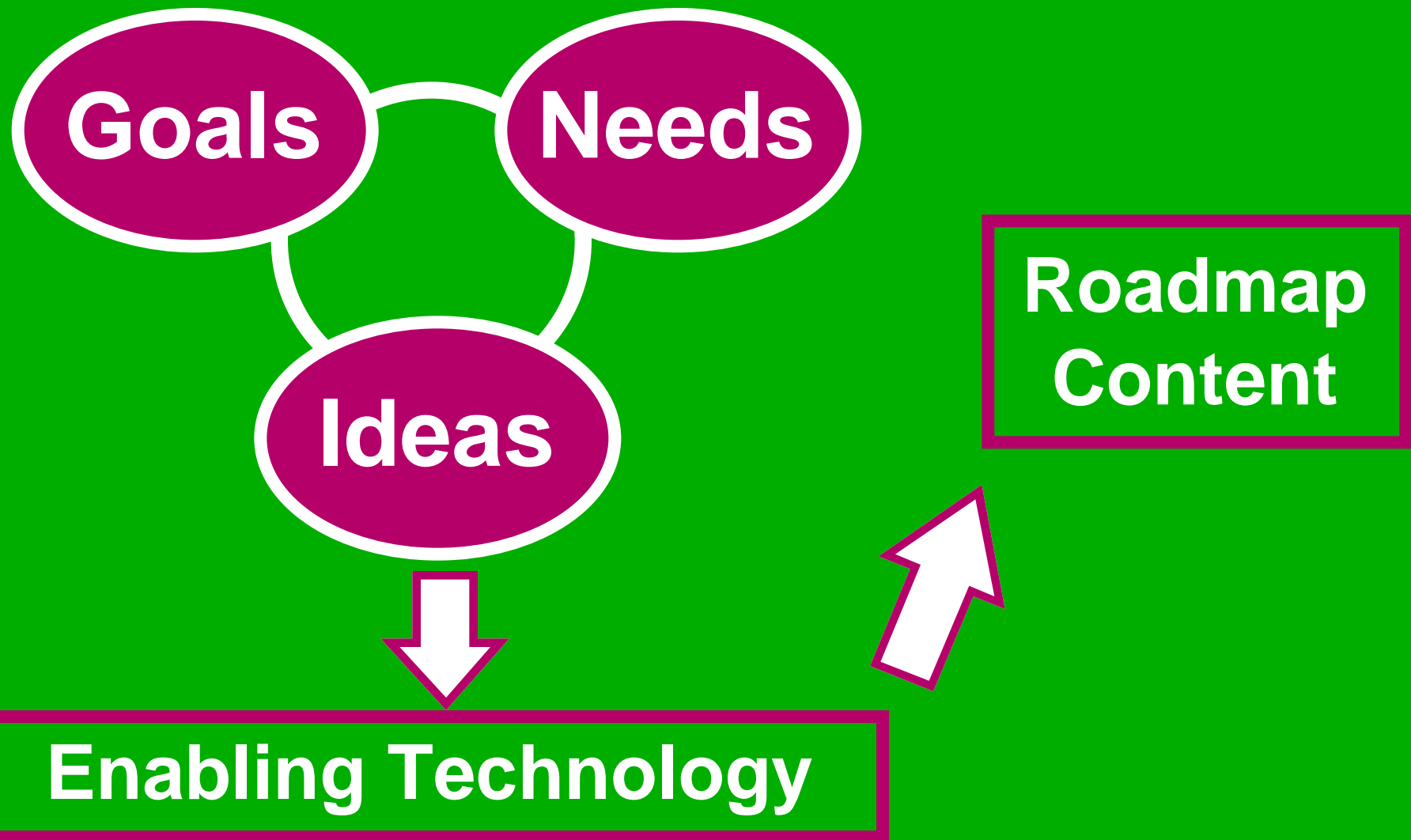
Engine Systems/Airframe Systems Noise Report

Bill Willshire

2nd ECoA Workshop

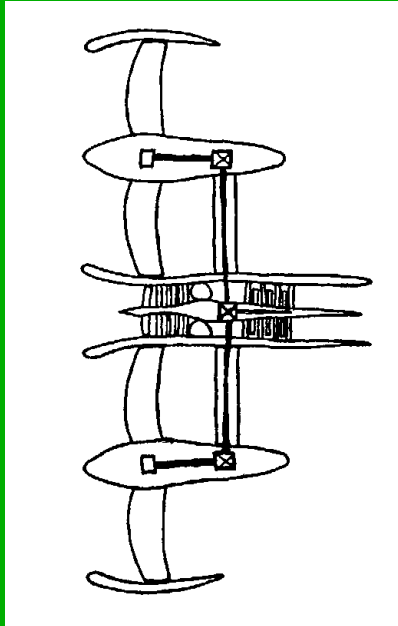
May 21, 1998

Breakout Process (Workshop Process)

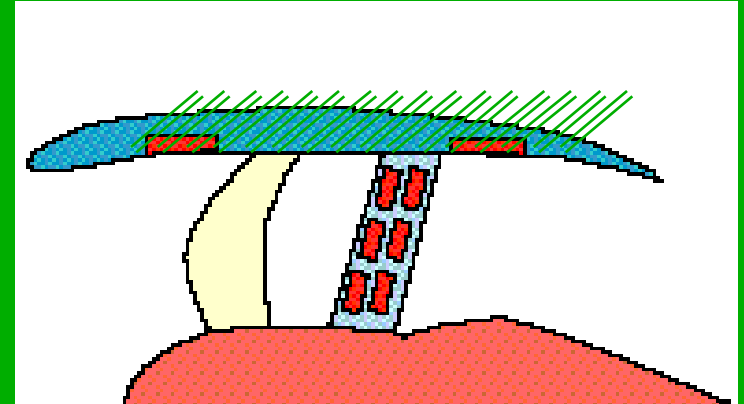


Engine Systems Noise Reduction

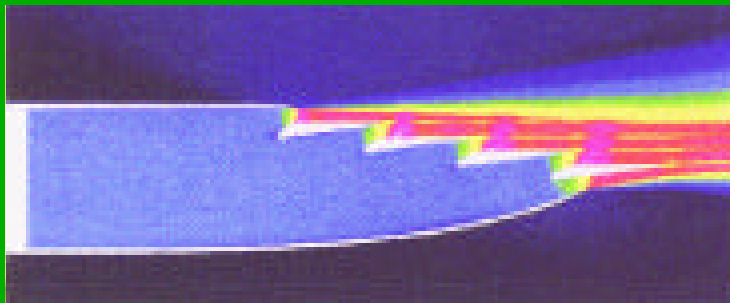
Advanced Concepts



**Single Core -
Multiple Fans**



**Active/Aspirating
Nacelle**



**Distributed
Exhaust**

Engine Systems

Advanced Concept - Dual Fan

Enabling Technologies:

- **Advanced, light-weight gearbox**
- **Thrust reversing**
- **Variable pitch**
- **Nacelle drag reduction**
- **Propulsion Airframe Integration**
- **Operability**

Engine Systems - Summary Chart

Advanced Concepts

Multistage Fans
Variable Cycle Engines
Dual Fan
Mini-Nozzles
Linear Accelerator
Counter-rotating Fan
Adaptive Engine/Nacelle
Advanced Liners
UHB Ducted Propeller
Modular Liners

Micro-engines

Enabling Technology

Core noise reduction
Active source control
Seeded exhaust
Rotor/stator noise reduction
Jet noise reduction
Composite/Smart materials
Advanced gear boxes
Propulsion airframe integration
Flow management/Micro blowing
MEMS
High temperature materials
Computational Aeroacoustics
Nozzle performance
Low speed fans
Statorless fan

Engine Systems Noise Level II Roadmap

Environmental Program

- Active/Adaptive Nacelles
- Distributed exhaust
- Flow Management
- PAI

-16 dB Engine systems TRL 6

Revolutionary A/C System Development

Revolutionary concept Downselect

- Rotor/Stator Interaction
- Low Speed Fans
- Core
- Jet

-12 dB Engine system TRL 6

Revolutionary A/C Component Develop

AST Hand-off

- 8 dB Engine System TRL 6

- Nacelle Liners
- Fan Noise
- Jet Noise

AST Noise Reduction Program

Fundamental Technologies Programs

- Numerical Techniques
- Actuators
- Measurements(PIV,DGV, arrays, ...)
- Turbulence Control

FY97

FY02

FY07

FY12

FY17

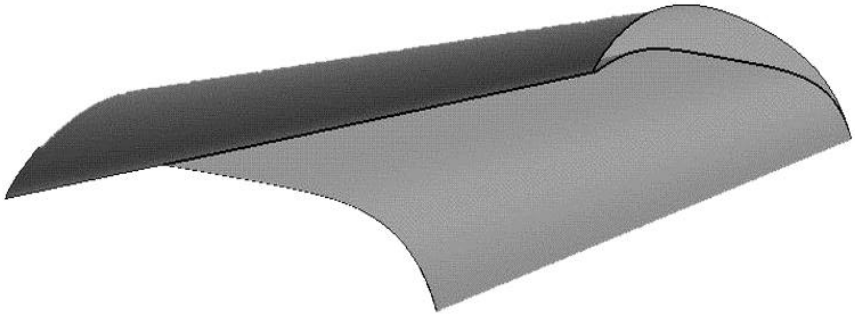
NAR

2X Reduction EIS

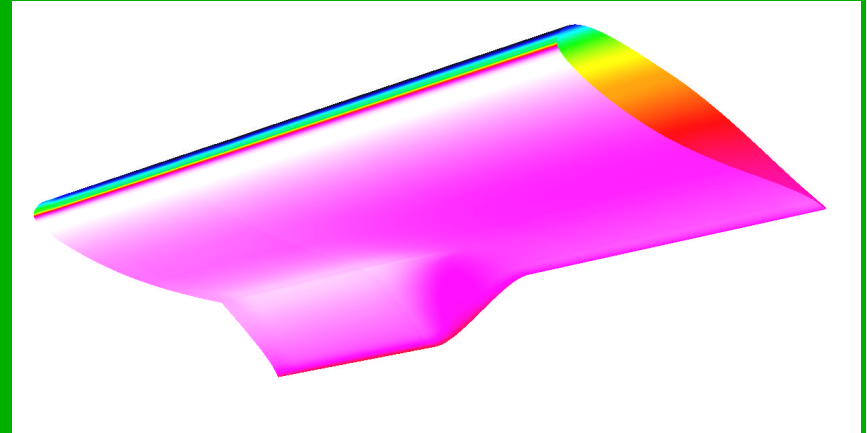
4X Reduction EIS

Airframe Systems Noise Reduction

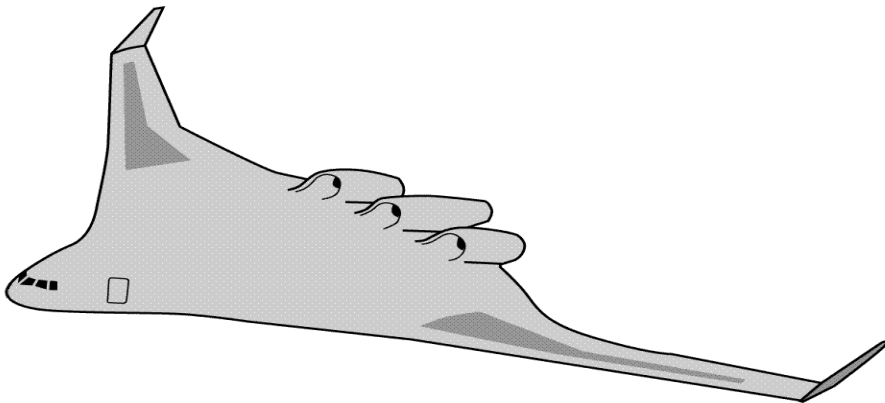
Advanced Concepts



Adaptive Surface Wing



Variable Camber Wing



Blended Wing Body

Airframe System

Advanced Concept - Adaptive Wing

Enabling Technologies:

- Smart materials/structures
- Actuation
- Digital control systems
- Dynamic load alleviation
- Computational Aeroacoustics (CAA)
- Propulsion airframe integration (PAI)
- Safety

Airframe System - Summary Chart

Advanced Concepts

Variable Camber
Adaptive Wing
Blended Wing Body
Gearless Design
Strut-Braced Wing
Box Wing
Dual Fuselage
Advanced High-Lift
Buried Engine
Far-field ANC
Lifting Nacelle

Enabling Technology

Turbulence control (surface treat.)
Smart materials/structures
CAA/CFD (inverse design)
Propulsion airframe integration
Composites
Flow control
Active Noise Control (ANC)
Trailing edge noise reduction
Engine installation for high-lift
Inflow distortion management
Laminar flow
Micro blowing
MEMS
Aero performance

Airframe Systems Noise Level II Roadmap

Environmental Program

- Eng-A/F Integration/Optimization
- Micro Blowing
- CAA Inverse Design Tools
- MEMS

- 12 dB Airframe Reduction TRL 6

Revolutionary A/C System Development

Revolutionary concept Downselect

- Flow Management
- Structural Acoustics
- Materials

- 9 dB Airframe Reduction TRL 6

Revolutionary A/C Component Development

AST Hand-off

- 4 dB Airframe Reduction TRL 6

AST Noise Reduction Program

Fundamental Technologies Programs

- Empirical Models
- Gear
- Flap/Slat

- Numerical Methods
- Turbulence Control
- Active Structure
- Active Flow Control

FY97

FY02

FY07

FY12

FY17

NAR

2X Reduction EIS

4X Reduction EIS

Noise/Emissions Coordination

- **Timing of advanced concepts**
- **Combustors**
- **Operations**
- **...**

Concluding Remarks

- **General agreement on program**
 - **Need**
 - **Framework**
 - **Areas of concentration**
- **Good beginning on Roadmap content**